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Effects of pyroligneous acids (wood vinegar) produced from different wood species on vegetative growth of eggplant (*Solanum melongena* L.)

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ABSTRACT

Pyroligneous acids are natural distillations which are extracted from the slow pyrolysis technique as a by-product of charcoal production. This magical natural extract helps to replace synthetic chemicals in the form of the plant growth regulator, biocide as well as the pesticides and improves the quality and the medicinal value of fruits and vegetables. Evaluation the vegetative growth of eggplant (Solanum melongena L.) as affected by pyroligneous acids produced from different wood species are very much important. Pyroligneous acid was prepared by using the wood species of Gliricidia sepium, Cinnamomum zeylanicum, Acacia leucopholea, and Azadirachta indica. Different concentrations (0%, 0.25%, 0.50%, 0.75%, and 1.0%) of the Pyroligneous acid were applied as a foliar spray (50ml/plant) with one-week intervals when the plant is having 4-5 leaves per each plant. Eggplant (Solanum melongena L.) used as the test plant for the experiment. A pot experiment was laid out in Complete Randomized Design (CRD) with twenty treatment combinations and four replications. Treatments were applied four times with one-week interval. Numbers of leaves, plant height, stem girth, number of branches was collected as the growth parameters. Data were collected one week after the application of each treatment. Results revealed that, application of 1% pyroligneous acid for Solanum melongena plant has significantly increased 20% of the mean number of leaves, 20% of the mean plant height, 10% of stem girth, 40% of number of branches when compared to the control (0%). Among the Pyroligneous acid prepared from different species 1% concentration of the acid prepared from Gliricidia sepium acids showed the significantly highest number of branches when compared with other treatments.

Keywords : Pyroligneous acid, Growth, Wood species, Concentrations, Medicinal

INTRODUCTION

Brinjal (*Solanum melongena L.*), is one of the popular, widely cultivated and principal vegetable crops in subtropical and tropical countries of the world, including Sri Lanka. In Sri Lanka, brinjal is one of the most favoured local vegetables and is cultivated by farmers in reasonable quantities in dry and rainy seasons, while other vegetables are in lack of supply (Karunakaran *et al.*, 2010). Eggplant is the common name for a perennial plant, *Solanum melongena*, of the potato or nightshade family Solanaceae(Newworldencyclopedia.org, 2019). Some of the plant growth regulators significantly improve the fruit quality (Kavyashree *et al.,* 2018) as well as the vegetative growth. Wood vinegar consider as one of the plant growth regulators further wood vinegar/pyroligneous acids are an organic liquid mixture produced through condensing the smoke produced during the carbonization or pyrolysis of wood and its residues from processing. Acetic acid is the major compound of wood vinegar and it also contains acids, phenols, alcohols, esters, carbonyl and furans and other organic ingredients (Yatagai *et al.*, 2002, Yoshimoto, 1994, Baimark and Niamsa, 2009). Yoshimura and Hayakawa (1991) reported that wood vinegar application is promoting fruit maturation. Wood vinegar has been used in a variety of processes, such as industrial, livestock, household and agricultural products.Therefore, application of wood vinegar/ pyroligneous acid to vegetable production may help to reduce the use of both chemical pesticides and chemical fertilizers.The objective of the study is to assess the growth performances of Brinjal (*Solanum melongena* L.) as affected by different concentrations of wood vinegar/pyrolegnious acids produced by different wood species.

MATERIALS AND METHODS

The experiments were carried at the University of Colombo Institute for Agro technology and Rural Sciences, Weligatta, Hambanthota, Southern Sri Lanka. *Solanum melongena*(eggplant) variety "*Lena iri*" wasused for the experiment. Four different wood species namely *Gliricidia sepium* (Gliricidia) *Cinnamomum zeylanicum* (Cinnamon), *Acacia leucopholea* (Katuandara) and *Azadirachta indica* (Kohomba) were selected as sources of pyroligneous acids.

Extraction of pyroligneous acids

A metal barrel with 200L capacity was used as improvised equipment for thermal decomposition of the selected plant material under inert atmosphere and the resulting volatiles were passed through a condenser to collect pyroligneous acids of the plants.

Raising of *Solanum melongena*

Polythene bags were (20cm diameter and 30cm height) were filled with potting media consisting top soil, sand and compost at the ratio of 1:1:1. Twenty bags were transplanted with *Solanum melongena* variety "*Lena iri*" at the rate of two plants per pot.When the plants were 4-5 leaf stage the extracted pyroligneous acids were sprayed separately to the plants.

Experimental design and treatment application

The experimental design used for this experiment was 2 x 2 CRD factorial designs with four replicates. Purified pyroligneous acids were diluted with water to obtain 0.25%, 0.50%, 0.75% and 1% concentrations as treatments. Pyroligneous acid treatments were applied to the surface of the leaves with one-week intervals when the *Solanum melongena* plants were having four to five leaves per plant.

Wood species and pyroligneous acid concentrations act as two factors and four wood species *Gliricidia sepium* (C1), *Cinnamomum zeylanicum* (C2), *Acacia leucopholea* (C3) and *Azadirachta indica* (C4) and five concentrations of 0.00% (L1), 0.25% (L2), 0.50% (L3), 0.75% (L4), and 1.00% (L5) were used in the experiment with four replicates. All treatments were applied randomly.

Data collection

Data was collected from all plants with one-week interval after application of treatments. Number of leaves, plant height (cm), stem girth (cm), and number of branches was collected as the growth parameters.

Data analysis/Statistical method

The statistical packages of SAS used for analysis of data. Data analyzed using ANOVA and DMRT for the mean separations.

RESULTS AND DISCUSSION

Mean number of leaves

Table 1: Number of leaves of *Solanum melongena* as affected by main effect of pyroligneous acids concentrations

Treatments	Mean number ofleaves of*Solanum melongena*			
	1st week	2nd week	3rd week	4th week
L_1	5.31 ± 0.22 c	7.56 ± 0.22 d	9.81 ± 0.18 c	11.94 ± 0.20 e
L_2	6.00 ± 0.13 c	9.31 ± 0.11 c	12.06 ± 0.17 b	14.75 ± 0.17 d
L_3	6.62 ± 0.16 c	10.56 ±0.17 bc	13.31 ± 0.22 b	16.06 ± 0.19 c
L_4	8.12 ± 0.24 b	11.81 ± 0.23 b	15.06 ± 0.25 a	17.87 ± 0.24 b
L_5	9.50 ± 0.18 a	13.31 ± 0.22 a	16.31 ± 0.19 a	19.31 ± 0.18 a

** Means with the same letter(S) are not significantly different from each other according to DMRT at 5% significant level*

** The values are the means ± standard error of 80 plants in four replications.*

** Where; L_1-0% WV, L_2-0.25% WV, L_3-0.5% WV, L_4-0.75% WV, L_5-1% WV.*

Results revealed that (Table 1) the application of 1% WV (L5) and 0.75% WV (L4) concentrations of pyroligneous acids were significantly increased (P value<0.05) mean number of leaves in *Solanummelongena* plant throughout the experimental period when compared to the other concentrations of pyroligneous acids (Table 1).

Plant height

Table 2: Plant height of *Solanum melongena* as affected by main effect of pyroligneous acids concentrations

Treatments	Mean height values (cm) of *Solanummelongena*			
1st week	2nd week	3rd week	4th week	
L_1	5.31 ± 0.15 c	7.56 ± 0.16 d	9.81 ± 0.15 c	11.94 ± 0.15 e
L_2	6.00 ± 0.21 c	9.31 ± 0.20 c	12.06± 0.23 b	14.75 ± 0.23 d
L_3	6.62 ± 0.25 c	10.56± 0.22 bc	13.31± 0.20 b	16.06 ± 0.15 c
L_4	8.12 ± 0.26 b	11.81± 0.22 b	15.06± 0.20 a	17.87 ± 0.17 b
L_5	9.50 ± 0.26 a	13.31± 0.23 a	16.31± 0.23 a	19.31 ± 0.22 a

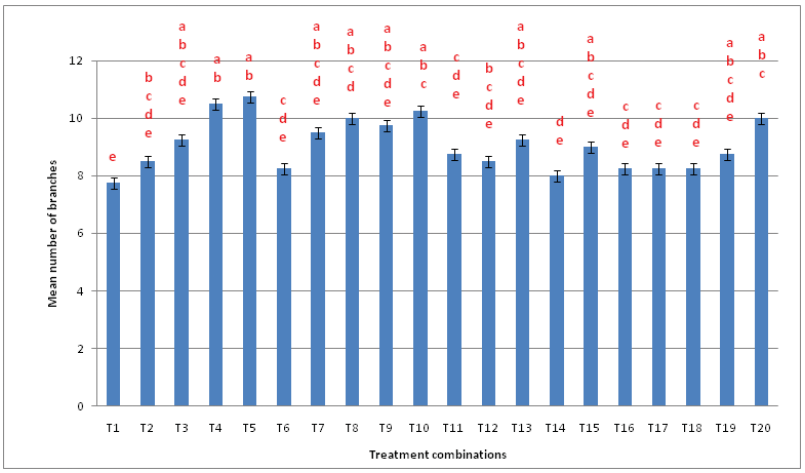
** Means with the same letter(S) are not significantly different from each other according to DMRT at 5% significant level*

** The values are the means ± standard error of 80 plants in four replications.*

** Where; L_1-0% WV, L_2-0.25% WV, L_3-0.5% WV, L_4-0.75% WV, L_5-1% WV.*

According to thetable (Table 2), 1% WV concentration of pyroligneous acids resulted a significantly increased (P value<0.05) mean plant height when compared to the other different concentrations of pyroligneous acids on *Solanum melongena* plant throughout experimental period.

Number of branches



(Figure 4.3: Mean number of branches of *Solanum melongena* as affected by treatment combinations at 4th week (Vertical lines indicate the standard error of the means)

** Means with the same letter are not significantly different from each other according to DMRT at 5% significant level*

** Where; T_1- Gliricidia sepium at 0% WV, T2-Gliricidia sepium at 0.25% WV, T3-Gliricidia sepium at 0.50% WV,T4-Gliricidia sepium at 0.75% WV,T5-Gliricidia sepium at 1.00% WVT6- Cinnamomum zeylanicum at 0% WV, T7- Cinnamomum zeylanicum at 0.25% WV,T8- Cinnamomum zeylanicum at 0.50% WV,T9- Cinnamomum zeylanicum at 0.75% WV,T10- Cinnamomum zeylanicum at 1.00% WV,T11- Acacia leucopholeaat 0% WV,T12- Acacia leucopholeaat 0.25% WV,T13- Acacia leucopholeaat 0.5% WV,T14- Acacia leucopholeaat 0.75% WV,T15- Acacia leucopholeaat 1.00% WV, T16- Azadirachta indica at 0% WV, T17- Azadirachta indica at 0.25% WV,T18- Azadirachta indica at 0.50% WV,T19- Azadirachta indica at 0.75% WV,T20- Azadirachta indica at 1.00% WV.*

The interaction effect from the treatment combination of T4 (*Gliricidia sepium* at 0.75% WV) , T5 (*Gliricidia sepium* at 1.00% WV), T8 (*T8- Cinnamomum zeylanicum at 0.50% WV*), T10 (*Cinnamomum zeylanicum at 1.00% WV*) and T20 (*Azadirachta indica at 1.00% WV*) were significantly increased (p value<0.05) mean number of branches of *Solanum melongena* plants at 4th week of the experimental period when compared to the control treatment combinations of T1 (*Gliricidia sepium at 0% WV)* (Figure 4.3). But T4(*Gliricidia sepium* at 0.75% WV) and T5 (*Gliricidia sepium* at 1.00% WV) treatment combinations did not show any significant difference (p value>0.05) each other.

Plant girth

Table 3: Mean girth (cm) of branches of *Solanum melongena* as affected by main effect of different pyroligneous acid concentrations

Treatments	Mean girth (cm) of *Solanum melongena*			
1st week	2nd week	3rd week	4th week	
L_1	1.92 ± 0.04 b	2.13 ± 0.04 c	2.36 ± 0.04 b	2.61 ± 0.04 b
L_2	1.92 ± 0.03 b	2.25 ± 0.04 c	2.46 ± 0.03 b	2.73 ± 0.03 b
L_3	1.99 ± 0.03 ab	2.32 ± 0.02 bc	2.54 ± 0.03 b	2.81 ± 0.03 b
L_4	2.05 ± 0.03 ab	2.44 ± 0.01 ab	2.76 ± 0.03 a	3.00 ± 0.03 a
L_5	2.14 ± 0.02 a	2.57 ± 0.02 a	2.85 ± 0.02 a	3.13 ± 0.02 a

** Means with the same letter(S) are not significantly different from each other according to DMRT at 5% significant level*

** The values are the means ± standard error of 80 plants in four replications.*

** Where; L_1-0% WV, L_2-0.25% WV, L_3-0.5% WV, L_4-0.75% WV, L_5-1% WV.*

Results from the above table (Table 3) exposed that the 1% WV concentrations of pyroligneous acids have shown a significantly increased (P value<0.05) mean of girth of *Solanum melongena* plants followed by the 0.75% WV concentration of pyroligneous acids when compared to 0% WV (control) concentration throughout the experimental period.Pyroligneous acids produced from different wood species were not significantly influenced (P value>0.05) on mean girth of *Solanum melongena* plants throughout the experimental period.

CONCLUSIONS

Mean number of branches of *Solanummelongena* plant were significantly increased with the application of pyroligneous acids produced by*Gliricidiasepium* wood species on 1% concentration when compared to the other interactions in later stage of the experimental period. Mean number of leaves and mean plant height of *Solanummelongena* plants were significantly increased (P value<0.05) at the1% concentration of pyroligneous acids (L5)throughout the experimental period when compared to the other concentrations of pyroligneous acids. Mean girth and mean number of branches of *Solanummelongena* plants were shown a significantly increased at the 1% concentrations of pyroligneous acids (P value<0.05) followed by the 0.75% concentration of pyroligneous acids when compared to 0% (control) concentration throughout the experimental period.

The optimization of such developmental traits thus has great potential to increase biomass and crop yield (Mathan, Bhattacharya and Ranjan, 2019).Recently, Ainsworth and Bush have suggested a need to increase source strength in order to improve yields (Ainsworth and Bush, 2011).

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